



Potential of Bamboo Fiber as a Matrix for Strengthening Sports Equipment

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Abstract. The analysis of the influence of the mechanical strength of bamboo fiber reinforced composites using polyester resin as an alternative to making tools for the sports industry, especially rock climbing, one of the products of which is volume, namely by replacing polypropylene fibers with bamboo fibers which are expected to have more capabilities than synthetic fibers, especially in their mechanical strength. , and this is also expected to have an impact on the environment, especially for users of natural fibers or in other words green environment. This study was conducted to determine the results of composites that have been added with bamboo fiber, which in this study the composition of bamboo fiber used was 5%, 10%, 15%, and the optimal results were obtained for its tensile strength with the ASTM D638 type 4 test standard, which is a composition of 5% with an average value of 15.05 kgf/mm². And making this bamboo fiber can be used as an alternative material to replace artificial fibers.

Keywords: composite, fiber, bamboo, strength, mechanical

1 Introduction

The development of material technology is very rapid at this time and many studies are carried out for material development such as those conducted by Arifin, et al. by utilizing aluminum powder material with ash [1] [2]. And there is a plastic manufacturing process carried out by Wang et al. [2] [4]. And then carried out by Hasan, et al. [5] with rubber material with clay as a substitute for vulcanizing heavy duty vehicle tires. And currently there is also a shift from the use of synthetic fibers to natural fibers as composite reinforcements. Although the production of natural fiber composites has begun, its use in Indonesia is still relatively minimal at this time. Natural fiber composites are used as the material of choice because they offer various advantages because they are one of the materials that are light, strong, corrosion resistant, efficient and there are still many other advantages that composites have.

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N. L. Husni et al. (eds.), *Proceedings of the 8th FIRST 2024 International Conference on Global Innovations (FIRST-ESCSI 2024)*, Advances in Engineering Research 261,
https://doi.org/10.2991/978-94-6463-678-9_4

Bamboo is not just a tree, but its bamboo fiber can be processed into a polymer composite reinforcement. This natural reinforcement is safe and environmentally friendly. Bamboo is also easily renewable and durable. Composites with bamboo fiber are stronger, more durable, and lighter. Bamboo fiber mixed with polyester produces a strong and lightweight composite. Two aspects that influence the tensile strength of the fiber are intrinsic aspects such as molecular load and extrinsic aspects such as fiber damage and its diameter size [6]. Previous research conducted by Djamil et al. bamboo have the potential to become an environmentally friendly composite material [7].

Currently, the sport that is widely favored by young people is rock climbing, a recreational sport that is currently popular in Indonesia. This sport is divided into two, namely rock climbing and wall climbing. Both types of rock climbing have different grip fields. Wall climbing is equipped with a board, point, and volume field to reach the top of the field that has been created. This equipment functions to support the weight of the feet, maintain body balance and function to help the feet support the body's weight when hanging at each point reached, so that when climbing the athlete will not fall easily [8]. Trained physical components cause large muscle explosion forces, on that day the strength of the rock climbing volume greatly influences climbing safety. The forces generated in rock climbing are pressure force, moment force, and tensile force, on the basis of this the author uses the tensile testing and impact testing methods [9].

This research find the strength of composites with bamboo fibers with polyester resin matrix and to develop composites from bamboo fibers. so that they can be used as matrices in the sports equipment industry, which will be applied in sports, especially rock climbing in volume media. The data from this study are expected to help designers and makers of rock climbing volumes in choosing the right material, so that they can improve the safety and reliability of rock climbing sports equipment in the future.

Methodology

Bamboo fiber is chosen as the raw material for the composite in this study because it is easily obtained in the surrounding environment, high quality, environmentally friendly, and economical. Polyester resin is the type of matrix used. The type of testing is with the ASTM D-790-03 ultimate test. The fiber and matrix content is 5%: 95%, 10%: 90%, 15%: 85%.

Catalysts play a crucial role in chemical processes. More than 75% of chemical production processes in industry use catalysts. Catalysts act as intermediaries that help reactions occur faster without being affected by the reaction itself. Catalysts are essential tools in various industries that enable efficient and environmentally friendly chemical production.

The flow chart research can be seen in fig 1.

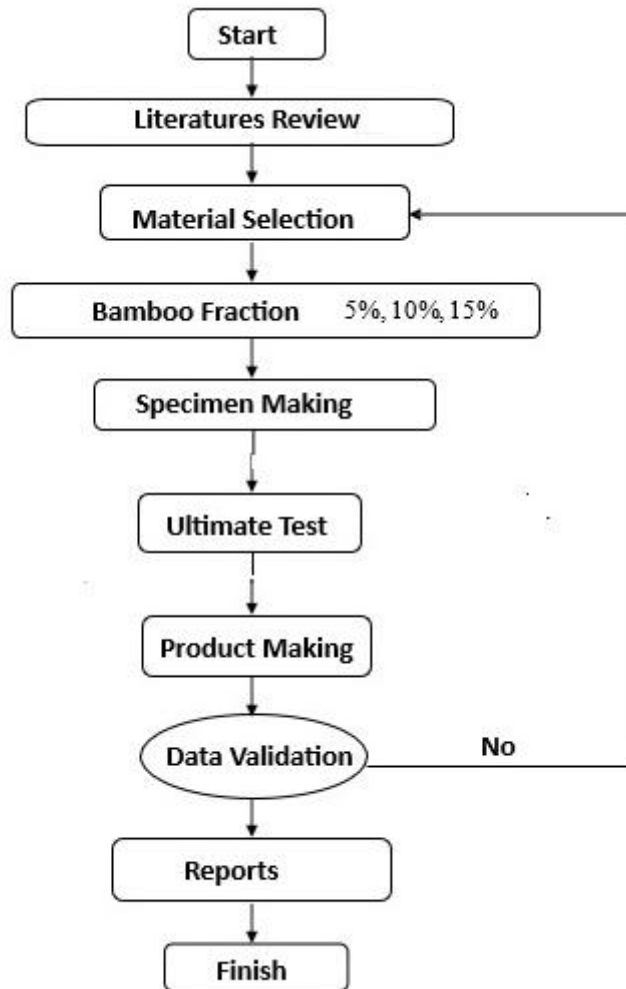


Fig 1. Flow Chart Research

The manufacture of bamboo fiber polyester composites is first carried out by cutting bamboo fibers which will later be used as a volume fraction of 5%, 10%, 15% with random placement variations. After the sample is ready, it is then tested for tensile strength. Fig 2 is the specimen ultimate test.



Fig 2. Specimen ultimate test

The data analysis method used in this study is the quantitative data analysis method, a set of statistical and mathematical techniques used to analyze numerical data. The analysis is carried out by conducting tests to obtain valid data as a comparison of the results with previous research for the manufacture of an object.

3. Result and Discussion

To find out the strongest composite variation, additional research was conducted on the highest value of bamboo fiber with tensile testing. From the results of composite testing with a polyester resin matrix reinforced with bamboo fiber, composite data was produced for each weight fraction with variations in fiber weight. These data are presented in Table 1. The test results shown that the composition of the reinforcing fiber can affect the tensile strength of the composite.

Table 1. The Test Result of Tensile.

Matrix	5%			10%			15%		
Percentage									
Specimens	1	2	3	1	2	3	1	2	3
Maximum Force (kgf/mm ²)	4022	3739	3617	4784	5205	4847	7242	4932	6390
Yield Strength (kgf/mm ²)	7,21	6,99	6,41	8,73	9,56	8,85	13,6	9,02	11,9
Tensile Strength (kgf/mm ²)	15,9	14,8	14,3	18,9	20,6	19,2	28,7	19,5	25,3
Elongation (%)	34	28	34	26	28	32	26	28	26

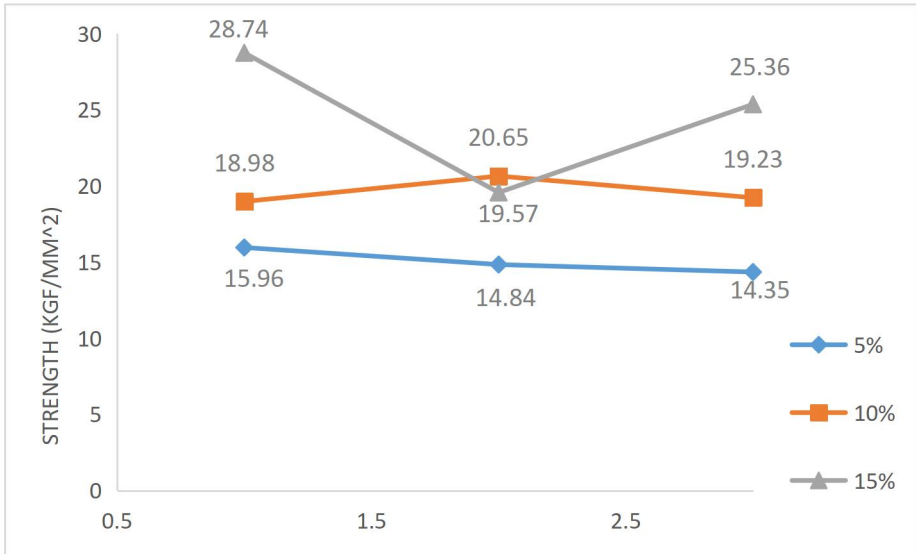


Fig 3. The tensile strength of bamboo matrix composite

It can be seen the ultimate test results, which were carried out on composites reinforced with bamboo fiber composition, the largest tensile strength is 15% of bamboo matrix fiber, namely with a maximum value of 28.74 kgf/mm². This occurs because the composite with 15% bamboo fiber has a rigid structure, so it is able to withstand tensile loads better than composites with a lower percentage (5% and 10%) which have a softer structure, this can be seen in figure 3. While for the maximum elongation in the 5% of bamboo matrix fiber, this is due to the catalyst which causes its elasticity to be higher compared to 10% and 15%.

4. Conclusion

Based on the experiment result, data processing, and discussions that have been carried out from all that has been discussed, knitting various information, it can be concluded that composites with bamboo fiber matrices can replace polyester fibers even though the tensile stress results are still lower when compared to synthetic matrix fibers. Where the length capability depends on the catalyst used.

Acknowledgement

Thanks to the Directorate of Vocational Higher Education through the PNPB Funding of Sriwijaya State Polytechnic in accordance with the Letter of Agreement for the Implementation of Research Assignment for Innovation Assignment Number: 07887/PL6.2.1/PG/2024 dated July 19, 2024.

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